AD-A132 081   STUDY OF POTENTIAL STANDARDIZATION OF VIDEO TELECONFERENCING SYSTEMS VOLU..(U) DELTA INFORMATION SYSTEMS INC JENKINTOWN PA R V COTTON ET AL. MAY 83   1/1

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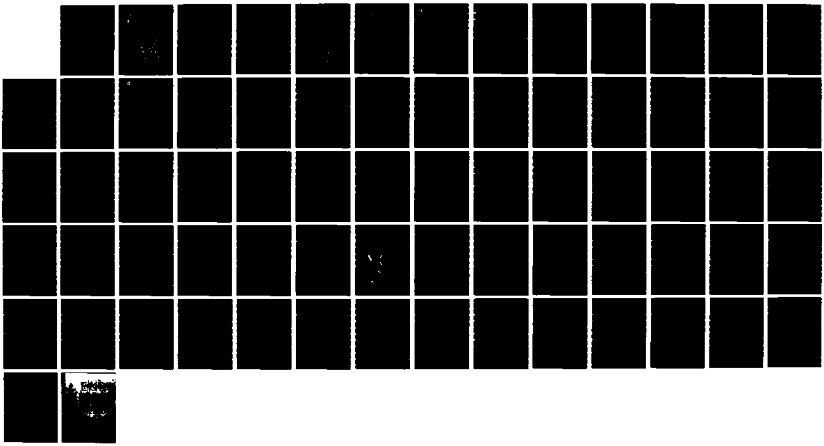

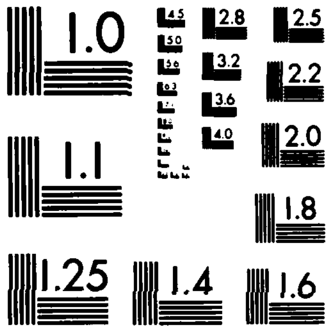

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NATIONAL COMMUNICATIONS SYSTEM

TECHNICAL INFORMATION BULLETIN
83-4

STUDY OF POTENTIAL STANDARDIZATION OF VIDEO TELECONFERENCING SYSTEMS VOLUME 2-APPENDICES

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: NCS TIB 83-4	2. GOVT ACCESSION NO.: AD-A132-081
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): STUDY OF POTENTIAL STANDARDIZATION OF [redacted] VIDEO TELECONFERENCING SYSTEMS VOLUME 2 - APPENDICES	5. TYPE OF REPORT & PERIOD COVERED: FINAL REPORT
	6. PERFORMING ORG. REPORT NUMBER: TSI 83-19
7. AUTHOR(s): ROBERT V. COTTON, RICHARD A. SCHAPHORST	8. CONTRACT OR GRANT NUMBER(s): DCA 100-82-C-0061
9. PERFORMING ORGANIZATION NAME AND ADDRESS: DELTA INFORMATION SYSTEMS, 310 COTTMAN STREET, JENKINTOWN, PA 19046	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: NATIONAL COMMUNICATIONS SYSTEM, OFFICE OF TECHNOLOGY AND STANDARDS, WASHINGTON, D.C. 20305	12. REPORT DATE: MAY 1983
	13. NUMBER OF PAGES: 64
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

SEE NCS TIB 83-4, VOLUME 1, FOR FINAL REPORT

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

VIDEO TELECONFERENCING
MOTION CODECS
DIGITAL TELEVISION

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

SEVERAL DIFFERENT FULL-MOTION TV TELECONFERENCING SYSTEMS USING NON-COMPATIBLE MOTION CODECS HAVE BEEN IMPLEMENTED. THESE VIDEO TELECONFERENCING SYSTEMS OPERATE AT VARIOUS DATA RATES WITH VARYING DEGREES OF PERFORMANCE. IN ORDER TO PROVIDE FOR THE COMPATIBILITY AND INTEROPERABILITY AMONG VIDEO TELECONFERENCING SYSTEMS, THE STUDY WAS INITIATED BY THE NATIONAL COMMUNICATIONS SYSTEM TO COMPARE EXISTING MOTION CODECS TO DETERMINE THE FEASIBILITY OF ESTABLISHING

(CONTINUED ON REVERSE SIDE)

20. (CONTINUED)

FEDERAL STANDARDS. THE OBJECTIVE WAS TO IDENTIFY THOSE PARAMETERS WHICH WOULD REQUIRE STANDARDIZATION IN ORDER TO ACHIEVE INTEROPERABILITY IN FULL-MOTION VIDEO TELECONFERENCING SYSTEMS.

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NCS TECHNICAL INFORMATION BULLETIN 83-4

STUDY OF POTENTIAL STANDARDIZATION OF

VIDEO TELECONFERENCING SYSTEMS

VOLUME 2 - APPENDICES

MAY 1983

PROJECT OFFICER

DENNIS BODSON
Senior Electronics Engineer
Office of NCS Technology
and Standards

APPROVED FOR PUBLICATION:

Dennis Bodson

DENNIS BODSON
Acting Assistant Manager
Office of Technology
and Standards

FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards, a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the Electronic Industries Association, the American National Standards institute, the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunication Union. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of digital video teleconferencing systems. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs or statements of requirements which could assist in the advancement of this work, are welcome and should be addressed to:

Office of the Manager
National Communications Systems
ATTN: NCS-TS
Washington, DC 20305
(202) 692-2124

TSI 83-19

DELTA INFORMATION SYSTEMS, INC.
310 COTTMAN STREET JENKINTOWN, PA 19046
(215) 572-5640

STUDY OF POTENTIAL STANDARDIZATION OF [redacted] VIDEO TELECONFERENCING SYSTEMS

APPENDICES

VOLUME 2

Submitted to:

NATIONAL COMMUNICATIONS SYSTEM

OFFICE OF TECHNOLOGY AND STANDARDS

ARLINGTON, VA 22204

Contracting Agency:

DEFENSE COMMUNICATIONS AGENCY

Contract Number

DCA100-82-C-0061

Submitted by:

DELTA INFORMATION SYSTEMS, INC.

310 Cottman Street

Jenkintown, Pa. 19046

This report composed of two volumes summarizes the work performed by Delta Information Systems, Inc., Jenkintown, PA. for the Office of Technology and Standards, National Communications System, Arlington, VA. under Contract DCA100-82-C-0061, entitled "Study of Potential Standardization of Digital Video Teleconferencing Systems". The contract monitor for the NCS was Mr. Dennis Bodson. The principal investigator for Delta Information Systems was Mr. Robert V. Cotton. Mr. Richard A. Schaphorst also participated in the study effort.

( )

Volume 2 List of Appendices

Table of Contents

GLOSSARY OF TERMS AND ABBREVIATIONS

The following terms and abbreviations have been used in the Final Report.

ABI	American Bell, Incorporated
A/D	Analog-to-digital
AEL	American Electronic Laboratories
AFB	Air Force Base
AMSAT	American Satellite Company
ANSI	American National Standards Institute
AT&T	American Telephone and Telegraph Company
BCH	Bose-Chaudhuri and Hocouengham
BER	bit error rate
bit	binary digit
BPS	bits per second
BR	bit rate
BT	British Telecom
BTI	British Telecom International
B-Y	color difference signal
C^2	command and control
CCIR	International Radio Consultative Committee
CCITT	International Telegraph and Telephone Consultative Committee
CLI	Compression Labs, Incorporated
cm	centimeter
CNS	Communications Network Service
codec	coder-decoder
CP	company proprietary
CRT	cathode ray tube

D/A	digital to analog
DCA	Defense Communications Agency
DCC	M/A-Com DCC, Incorporated
DCT	discrete cosine transform
DDS	Dataphone Digital Service
DES	Data Encryption Standard
DIS	Delta Information Systems, Incorporated
DOD	Department of Defense
DOE	Department of Energy
DPCM	differential pulse code modulation
EBU	European Broadcasting Union
EIA	Electronic Industries Association
FCC	Federal Communications Commission
FEC	forward error correction
F/SEC	frames per second
GSA	General Services Administration
HCTDS	High Capacity Terrestial Digital Service
HSSDS	High Speed Switched Digital Service
IEC	International Eelctrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IEU	International Engineering Forum
I/O	input/output
ISO	International Organization for Standardization
ITEJ	Institute of Television Engineers of Japan

JCIC	Joint Committe on Intersociety Coordination
KBS	kilobits per second
MBPS	See MBS
MBS	megabits per second
MCM	GEC-McMichael, Limited
MHz	megahertz
NA	not available
NAB	National Association of Broadcasters
NASA	National Aeronautical and Space Agency
NBC	National Broadcasting Company
NCS	National Communications System
NCTA	National Cable Television Association
NEC	NEC America, Incorporated
NR	no response
NTSC	National Television Standards Committee
PCM	pulse code modulation
PEL/Pixel	picture element
PMS	Picturephone Meeting Service
RCA	Radio Corporation of America
R/O	receive only
R-Y	color difference signal
SBS	Satellite Business Systems, Incorporated
SMPTE	Society of Motion Picture and Television Engineers

S/O	send only
SYNC	synchronization
TBD	to be determined
TV	television
WID	Widergren Communications, Incorporated
Y	luminance signal

APPENDIX B

Vendor Letter and Questionnaire Outline

B.1 Vendor Letter

The attached letter was sent to each known motion codec vendor and government agency known to be involved in motion codec development.

B.2 Questionnaire Outline

The attached outline contains a listing of the subject material which was requested in the initial and supplemental codec venor questionnaires.

B.1 Vendor Letter

DELTA INFORMATION SYSTEMS, INC.
310 COTTMAN STREET JENKINTOWN, PA 19046
(215) 572-5640

Attention:

Subject: Codec Vendor Questionnaire

Reference: DIS letter,

Dear

As a follow-up to the above referenced letter requesting information on your motion codec equipments, please find enclosed a Codec Vendor Questionaire which has been generated in order to obtain similar information from all vendors who are participating in this study for the National Communications System under Contract DCA100-82-C-0061. Your cooperation in providing this information and completing the questionnaire will insure that only approved and non-proprietary information and data will be used in the study.

Again the purpose of this NCS study is to examine and analyze all motion codecs being offered or used for digital video teleconferencing systems. The goal of the study is to recommend possible parameters which should be standardized in systems for use by the Federal Government to insure interoperability and compatibility within the various agencies. It is therefore most important that all the requested information be provided.

Perhaps a basic question should be considered when providing the data for the questionnaire - Why should your codec equipment be choosen as the standard equipment for the Federal Telecommunications Systems?

It is requested that you return the completed questionnaire to the undersigned by Thank you again for your assistance and cooperation.

B-2 Outline of Codec Vendor Questionnaires

Part 1. Product Nomenclature and General Description

1. Vendor Identification
2. Codec Identification
3. Pricing
4. Product Life
5. Warrantees
6. Service, Maintenance, Repairs, Spares, Training

Part 2. Technical Specifications. Input and Output Signals

1. Video Input Signals
2. Video Output Signals
3. Audio Inputs and Outputs
4. Digital Signals
5. Other Inputs/Ports

Part 3. Technical Specifications. Performance

1. Performance with Static Video Input
2. Performance with Motion Video Input
3. Bit Rate Performance
4. Compression Technique
5. Audio Performance

Part 4. Physical Description and Specifications

1. Mechanical Dimensions
2. Environmental Operation
3. EMI/EMC
4. Connectors

Part 5. Other Product Data

1. Status/Alarms
2. BITE
3. Front Panel/Operator Controls
4. Encryption/Scrambling
5. Documentation/Manuals
6. Brochures/Technical Notes

Supplemental Questionnaire

1. Description of frame length, bit rate, compatibility with ATT T1 protocol
2. Composition of frame word
3. Forward Error Correction
4. Encryption
5. Recommendations for standardized transmission bit stream

APPENDIX C

Codec Vendor and Organization Participants

C1 List of Initial Vendors

The following organizations were sent initial letters to solicit information for this study.

1. Compression Labs, Incorporated
   2305 Bering Drive
   San Jose, CA 95131

   POC: Mr. John Tyson

2. NEC America, Inc.
   2740 Prosperity Avenue
   Fairfax, VA 22031

   POC: Mr. S. Michael Stevenson

3. MACOM Laboratories
   1350 Piccard Drive
   Rockville, MD 20850

   POC: Dr. Leonard S. Golding

4. Widergren Communications, Inc.
   1190 S. Bascom Ave., Suite 220
   San Jose, CA 95128

   POC: Mr. Robert Widergren

5. E-Systems, Inc.
   P.O. Box 226118
   Dallas, TX 75266

   POC: Jim Carr

6. Motorola, Inc.
   Government Electronics Division
   7402 S. Price Road
   P.O. Box 22050
   Tempe, AZ 85282

   POC: Mr. Ron Levetin

7. Digital Communications Corporation
11717 Exploration Lane
Germantown, MD 20767

POC: Mr. Donald L. Blanchard

8. American Telephone and Telegraph Company
Room 3A120
Bedminster, NJ 07921

POC: Ms. Linda Lunga

9. ISACOMM
1815 Century Blvd., Suite 500
Atlanta, GA 30345

POC: Mr. Robert Reid
Mr. Victor Reed

10. Air Force Communications Command
1842 EEG/EE1CB
Scott AFB, IL 62225

POC: Capt. James McMillian

11. United States Army
Combined Arms Center
ATTENTION: ATZL-CAC-IA (Lynn)
Ft. Leavenworth, KA 66027

POC: Capt. Donald Lynn

12. Television Audio Support Agency
Sacramento Army Depot
Sacramento, CA 95813

POC: Mr. Mark Eubanks

13. U.S. Army Communications Command
Attention: CC-OPS-PR (Mr. Hill)
Ft. Huachuca, AZ 85613

POC: Mr. Lloyd Hill

14. AF/MPE
Room 4E207
The Pentagon
Washington, DC 20330

POC: Capt. Gary Boyle

15. Decisions and Designs, Inc.
Suite 600
8400 Westpark Drive
P.O. Box 907
McLean, VA 22101

POC: Mr. Charles King

16. CEEIA
Fort Huachuca, AZ 85612

POC: Mr. Pat Tufts

17. National Security Agency
9800 Savage Road
Ft. George C. Meade, MD 20755

POC: Mr. M. Rogers

18. Office of Secretary of Defense
Deputy Undersecretary of Defense of C^3I
Room 3D174
The Pentagon
Washington, DC 20301

POC: Dr. James Reilly

19. British Telecom International
Pemberton House
East Harding Street
London EC4A 3AS
England

POC: Mr. Peter Carpenter

20. CECOM
Attn: DRSEL-COM-D
Ft. Monmouth, NJ 07703

POC: Mr. Eugene Famolari

21. American Bell, Inc.
1776 On-the-Green
Morristown, NJ 07960

POC: Mr. Edward J. Fontenot

22. American Electronic Laboratories
P.O. Box 552
Lansdale, PA 19446

POC: Mr. Richard Michael

23. GEC McMichael Ltd.
Sefton Park
Stoke Poges, Slough SL2 411D
England

POC: Mr. Tim Duffy

APPENDIX D

Partial Submissions from

British Telecom International

to the CCITT. This material received from

British Telecom International

1. Contribution No. 123 - Frame Structure Standard

2. Contribution No. 134 - Codec Standard

International Telegraph and Telephone
Consultative Committee
(CCITT)

Period 1981-1984

Corrigendum to
COM XV-No. 123

Original : English

Question : 4/XV

Date : October 198

STUDY GROUP XV - CONTRIBUTION No. 123 (CORRIGENDUM)

SOURCE : BRITISH TELECOM

TITLE : PROPOSAL FOR A NEW RECOMMENDATION ON A FRAME STRUCTURE FOR DIGITAL TRANSMISSION OF VIDEOCONFERENCE SIGNALS AT 2048 kbit/s

As stated in document COM XV-No. 123, studies on the frame structure are still in progress. Moreover, as forecast in the document, these studies have led to a number of detailed changes in the bit allocations used for codec-to-codec signalling, as specified in Section 3 of the Annex to document COM XV-No. 123. This Corrigendum presents an updated versioh of Section 3 of the Annex, which replaces the whole of Section 3 of the original document, except Table 2 which remains unchanged.

Further changes may be required as studies progress, but it is believed that any such changes will be of a minor nature.

In the Annex of COM XV-No. 123, replace Section 3 (on pages 5 and 6 of the English text) by the following. Table 2, on page 7, remains unchanged.

New text :-

3. Codec-to-codec information

This information is transmitted in the 32-kbit/s channel corresponding to TS 2 in odd frames.

The 32-kbit/s channel is structured in a multiframe and supermultiframe derived from 128 consecutive 256-bit frames. The multiframe is composed of 8 octects numbered 1, 3, 5, ..., 15, each from TS 2 in an odd numbered 256-bit frame. The supermultiframe corresponds to 8 consecutive multiframes which are numbered 0,1,2,...,7.

The use of the bits in each octet in the odd frames is as follows :-

- Bit 1 for clock justification

- Bit 2 for buffer state

- Bit 3 for coding mode identification; the 8 consecutive bits 3 of TS 2 in a multiframe will carry the following information:

  Bit 3.1* Codec facilities (see below)

  Bit 3.3 Colour transmission (1 if provided)

  Bit 3.5 Spare (set to 0)

  Bit 3.7 Fast update request (1 if required)

  Bit 3.9 Advance warning of interruption (1 if required)

  Bit 3.11 Sound power signal, for use with encrypted multipoint (under study)

  Bit 3.13 Broadcast mode (1 if required)

  Bit 3.15 Spare (set to 0)

Bit 3.1 is used to signal the availability of certain facilities in the decoder at supermultiframe rate, as follows:

  Bit 3.1.0 Graphics (1 if provided)

  Bit 3.1.1 High quality speech (1 if provided)

  Bit 3.1.2 1.5 Mbit/s operation (1 if provided)

  Bit 3.1.3 Encryption (1 if provided)

  Bits 3.1.4 to 3.1.7 Spare (set to 0)

- Bit 4 to identify the use of time slots; the 8 consecutive bits 4 of TS 2 in a multiframe will carry the following information:

  Bit 4.1 TS 2(even) is used for video (0) or other (1)

  Bit 4.3 TS 16 is used for video (0) or other (1)

  Bit 4.5 TS 17 is used for video (0) or other (1)

  Bit 4.7 TS 18 is used for video (0) or other (1)

  Bit 4.9 TS 16, 26, 27, 28. 29, 30, 31 are used for video (0) or other (1)

  Bit 4.11 Graphics transmission (1 if required)

  Bit 4.13 Error correction (1 if required)

---

*The notation used here should be interpreted as in the following examples: Bit 3.1 means Bit 3 (in TS 2) of frame No.1 in each multiframe: Bit 3.1.0 means Bit 3 (in TS 2) of frame No.1 in multiframe No.0 of each

Bit 4.15 Spare (set to 0)

- Bit 5 for multipoint conferencing; provides a 4 kbit/s message channel (transparent through the codec) from customer to multipoint control unit, between control units and from customer to customer.

- Bits 6,7 free, for possible national use

- Bit 8 for multiframe and supermultiframe alignment; the values of bit 8 in each frame of the multiframe (multiframe and supermultiframe alignment patterns) should be as detailed in Table 2.

The conditions signalled in bits 3 and 4 can only change at supermultiframe rate. The change at the decoder will take place at the start of the first supermultiframe following the one where the change in signalling has been detected. This procedure can be used to improve the resistance to transmission errors.

(Table 2 follows)

International Telegraph and Telephone
Consultative Committee
(CCITT)

Period 1981-1984

Addendum 1 to
COM XV-No.134-E

Original : English

Question : 4/XV

Date : October 1982

STUDY GROUP XV - CONTRIBUTION No.134 (ADDENDUM No.1)

SOURCE : BRITISH TELECOM

TITLE : A CODEC FOR VIDEOCONFERENCING USING 2048 kbit/s TRANSMISSION

As stated in document COM XV-No.134 , studies on the codec are still in progress. One important topic about which no details were included in the document is the provision of facilities for colour transmission. Studies on this topic have now progressed to the stage where the basic technique to be employed can be specified, although many of the details and the optimum values of parameters are still under study.

This Addendum provides a preliminary text for Section 7 of the proposed new Recommendation, setting out the principles of the method to be used for colour transmission.

More detailed specifications will be provided as studies progress.

New text for Section 7 :-

7. Colour Facilities

When colour is being transmitted, the input (and output) video signals are in component form. The luminance and colour-difference components, E'_Y , E'_U and E'_V , are as defined in CCIR Report 624-2. The luminance component, E'_Y , is processed in exactly the same manner as the monochrome signal, as described in Section 3.

The colour-difference signals are each sampled to produce 52 samples per active line and are converted to 8-bit pcm. The sampling patterns, the arrangement of the samples and the quantisation levels are under study.

The E'_U and E'_V samples are stored and transmitted on alternate lines of the coded picture. The first active line of field No.1 is E'_U and the first active line of field No.2 is E'_V. The colour-difference signal not being transmitted during any line is obtained at the decoder by interpolation.

The colour-difference signals are coded using conditional-replenishment techniques similar to those used for the luminance (or monochrome) signal.

The colour-difference signals are multiplexed with the luminance signal (and addressing and synchronisation data) in the Video Multiplex Coder.

Studies on the details of the above are continuing.

ANNEX 1

DRAFT RECOMMENDATION

CHARACTERISTICS OF A 2048-kbit/s FRAME STRUCTURE FOR USE IN THE INTERNATIONAL INTERCONNECTION OF DIGITAL CODECS FOR VIDEOCONFERENCING OR VISUAL TELEPHONY

1. General Characteristics

The multiplex structure described in this Recommendation is suitable for use on digital paths and connections which interconnect video codecs for videoconferencing or visual telephony using 2048-kbit/s transmission. The connections may either be direct or via higher-order digital multiplex equipment compatible with the primary PCM multiplex equipment defined in Recommendation G.732.

Some of the characteristics of this multiplex structure are identical to those in Recommendation G.732 and are covered by cross references to that Recommendation.

The main features of the multiplex structure are that it provides :

- one 64-kbit/s channel for frame alignment, alarm signals and other signals as required;
- one 64-kbit/s channel reserved for the transmission of the sound signal;
- one 32-kbit/s channel for codec-to-codec information;
- the option of one or two 64-kbit/s channels for stereophonic sound, facsimile, data, etc;
- the possibility of end-to-end and subscriber-to-network signalling;
- the remaining capacity (between 1664 and 1888 kbit/s) is used for the encoded video signal.

Note :
Interworking between regions using different television standards and/or digital hierarchies based on 1544 kbit/s requires urgent study.

1.1 Fundamental Characteristics

The multiplex structure contains 32 time slots, each of 64 kbit/s.

1.2 Bit Rate

The nominal bit rate is 2048 kbit/s. The tolerance on this rate is ± 50 parts per million (ppm).

1.3 Timing Signal

The timing signal is a 2048-kHz signal from which the bit rate is derived. It should be possible to derive the timing signal from an internal source or from the network.

1.4 Interfaces

The interfaces should comply with Recommendation G.703.

2. Frame Structure and Time Slot Allocation

The frame structure follows Recommendation G.732 with changes in the Time Slot (TS) allocations. The TS allocations within the 256-bit digital frame of Recommendation G.732 are given in Table 1; three options being considered for subscriber-network signalling are indicated as (i), (ii) and (iii).

TABLE 1

Time-Slot Allocation in 32 Time-Slot Frame Structure of Rec G.732

		TIME-SLOT ALLOCATION (within the 256-bit frame)		
	BIT RATE (kbit/s)	NON SWITCHED (i)	SWITCHED (ii)	SWITCHED (iii)
Frame Alignment, Network Alarms, etc	as in G.732	0	0	0
Speech information	64	1	1	1
Codec-to codec information	32	2	2	2
Signalling information (subscriber-network)	16	-	16	0
Fax, data, etc (optional)	up to 2 x 64	17 and/or 18	17 and/or 18	17 and/or 18
Encoded video information (minimum)	(i) 27 x 64 (ii) 26 x 64 (iii) 27 x 64	3 to 16 + 19 to 31	3 to 15 + 19 to 31	3 to 16 + 19 to 31

The following Notes apply to Table 1 :-

1. Frame alignment, network alarms, etc
This information is transmitted in TS 0 with the same rules and characteristics as recommended in Recommendation G.732.

2. Speech

Speech is transmitted at 64 kbit/s in TS 1. The coding law is that of Recommendation G.711 or, for future applications, the law that will be recommended by CCITT for higher quality speech. In the case of stereophonic transmission, the second speech channel will be transmitted in TS 17.

3. Codec-to-codec information

This information requires a capacity of 32 kbit/s and is transmitted on odd frames of TS 2. The remaining 32 kbit/s capacity on the even frames of TS 2 will be used for encoded video or data transmission. The detailed use and structure of the 32-kbit/s channel for codec-to-codec information is described in Section 3.

4. Signalling (subscriber-to-network)

A capacity of 16 kbit/s is considered adequate for videoconference as for basic access. The methods of switched access to the ISDN at 2048 kbit/s have not yet been formulated and this is the reason for the three variants (i), (ii) and (iii). For non-switched access, option (i) should be used. For switched access, the subscriber signalling and call set-up information should be within the frame structure. The final choice between options (ii) and (iii) requires further study.

Note

5. Facsimile, data, etc

When required, this information will be transmitted in TS 17 and/or 18.

6. Encoded video

A minimum of 26 x 64 kbit/s capacity is reserved for encoded video in TS 3 to 15 and 19 to 31. In addition, depending on applications, TS 2 (even frames), TS 16, 17 and 18 may also be used for video, providing a maximum of 29.5 x 64 kbit/s capacity; the available video bit-rate therefore lies between 1664 and 1888 kbit/s.

3. Codec-to-codec information

This information is transmitted in the 32-kbit/s channel corresponding to TS 2 in odd frames.

The 32-kbit/s channel is structured in a multiframe and supermultiframe derived from 128 consecutive 256-bit frames. The multiframe is composed of 8 octects numbered 1, 3, 5, ..., 15, each from TS 2 in an odd numbered 256-bit frame. The supermultiframe corresponds to 8 consecutive multiframes which are numbered 0,1,2,...,7.

The use of the bits in each octet in the odd frames is as follows :-

Note: It would seem option ii is preferred for ISDN but [illegible]

- Bit 1 for clock justification
- Bit 2 for buffer state
- Bit 3 for coding mode identification; the 8 consecutive bits 3 of TS 2 in a multiframe will carry the following information:

Bit 3.1*	Codec facilities (see below)	
Bit 3.3	Colour transmission	(1 if provided)
Bit 3.5	Spare	(set to 0)
Bit 3.7	Fast update request	(1 if required)
Bit 3.9	Advance warning of interruption	(1 if required)
Bit 3.11	Sound power signal, for use with encrypted multipoint	(under study)
Bit 3.13	Broadcast mode	(1 if required)
Bit 3.15	Spare	(set to 0)

Bit 3.1 is used to signal the availability of certain facilities in the decoder at supermultiframe rate, as follows:

Bit 3.1.0	Graphics	(1 if provided)
Bit 3.1.1	High quality speech	(1 if provided)
Bit 3.1.2	1.5 Mbit/s operation	(1 if provided) ϕ
Bit 3.1.3	Encryption	(1 if provided)
Bits 3.1.4 to 3.1.7	Spare	(set to 0)

- Bit 4 to identify the use of time slots; the 8 consecutive bits 4 of TS 2 in a multiframe will carry the following information:

Bit 4.1	TS 2(even) is used for video (0) or other (1)
Bit 4.3	TS 16 is used for video (0) or other (1)
Bit 4.5	TS 17 is used for video (0) or other (1)
Bit 4.7	TS 18 is used for video (0) or other (1)
Bit 4.9	TS 16, 26, 27, 28, 29, 30, 31 are used for video (0) or other (1)
Bit 4.11	Graphics transmission (1 if required)
Bit 4.13	Error correction (1 if required)

---

*The notation used here should be interpreted as in the following examples: Bit 3.1 means Bit 3 (in TS 2) of frame No.1 in each multiframe: Bit 3.1.0 means Bit 3 (in TS 2) of frame No.1 in multiframe No.0 of each supermultiframe. this facility

ϕ should be studied (if requested) in the general framework

Bit 4.15 Spare (set to 0)

- Bit 5 for multipoint conferencing; provides a 4 kbit/s message channel (transparent through the codec) from customer to multipoint control unit, between control units and from customer to customer.

- Bits 6,7 free, for possible national use

- Bit 8 for multiframe and supermultiframe alignment; the values of bit 8 in each frame of the multiframe (multiframe and supermultiframe alignment patterns) should be as detailed in Table 2.

The conditions signalled in bits 3 and 4 can only change at supermultiframe rate. The change at the decoder will take place at the start of the first supermultiframe following the one where the change in signalling has been detected. This procedure can be used to improve the resistance to transmission errors.

TABLE 2

Multiframe and Supermultiframe Alignment on Bit 8 of TS 2 (odd)

Multiframe alignment pattern

Frame 1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1
7	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
11	1	1	1	1	1	1	1	1
13	0	0	0	0	0	0	0	0
15	1	1	1	0	0	1	0	*
Multiframe	0	1	2	3	4	5	6	7

Supermultiframe alignment pattern

* Undefined (reserved for possible future use in a higher level framing structure).

ANNEX 3 For Info Only

International Telegraph and Telephone
Consultative Committee
(CCITT)

Period 1981-1984

Addendum 2 to
COM XV-No.134-E

Original : English

Question : 4/XV

Date : October 1982

STUDY GROUP XV - CONTRIBUTION No. 134 (ADDENDUM No.2)

SOURCE : BRITISH TELECOM

TITLE : A CODEC FOR VIDEOCONFERENCING USING 2048 kbit/s TRANSMISSION

ADDENDUM No.2 - INTER-REGIONAL OPERATION

1. Introduction

The codec described in COM XV-No.134 has been developed in collaboration with several European countries and consequently has been based on European television standards (625 lines, 50 fields/s) and a level in the digital hierarchy used in Europe (2048 kbit/s). The importance of being able to interwork with regions using other television standards and other digital hierarchies has always been fully recognised. The companion contribution (COM XV-No.123) allocates control signals within the 2048 kbit/s frame structure to facilitate interworking with regions using the 1544 kbit/s frame structure. This contribution gives a preliminary outline of changes required in a second version of the codec, designed to permit inter-regional operation.

2. Requirements

Inter-regional operation involves the use of two television standards and two digital standards, as indicated in the Table.

TABLE

Television standard	Digital standard
625 lines, 50 fields/s CCIR Rec No.472	2048 kbit/s CCITT Rec No.G.732 COM XV-No.123
525 lines, 60 fields/s System M in CCIR Rep No.624	1544 kbit/s CCITT Rec No.G.733

Full flexibility involves all combinations of these standards but, at present, it seems that the most frequently occurring one will be 625-line television and 2048 kbit/s interworking with 1544 kbit/s and 525-line television. This combination is considered in the present contribution but, if a firm demand arises, the others could readily be provided using the same principles.

3. Transcoding between digital hierarchies

To permit transcoding between the 2 Mbit/s and 1.5 Mbit/s hierarchical levels, the 1.5 Mbit/s codec sends a signal to the 2 Mbit/s codec, using bit 4.9 in Time Slot 2 of the codec-to-codec signalling channel within the 2048 kbit/s frame structure (see COM XV-No. 123). This causes the 2 Mbit/s coder to remove the video data from Time Slots 16 and 26 to 31 inclusive, and to ignore any video data received in these Time Slots at the decoder. Thus, the information rate within the 2048 kbit/s frame is reduced to 1536 kbit/s.

A multiplex conversion unit (or transcoder) is required at the interface between the 2048 kbit/s and 1544 kbit/s digital paths to produce frame structures compatible with Rec G.732 on one side and Rec G.733 on the other. The G.732-compatible frame structure is already specified (COM XV-No.123) but the G.733-compatible frame is not yet specified.

4. Conversion between television standards

Conversion between the television scanning standards is also required. This might be done using field-store standards converters of the types used for broadcasting (see, for example, CCIR Report 311). However, these converters are highly complex and costly, and the more modern ones are capable of giving pictures of a much higher standard of quality than could be achieved in systems using 1.5 or 2 Mbit/s digital transmission. In view of the fact that the codecs already contain picture stores (essential elements in field standards converters), it has been decided to incorporate a simplified conversion process in the 525-line version of the codec.

4.1 Field conversion

The difference in field frequency of the two television standards causes the 525-line decoder to receive the moving areas from 5 fields from the 625-line coder in the time that it expects to receive 6 fields (from a 525-line coder). In the other direction (525-line to 625-line), 6 fields are received in the time that 5 fields are expected. This situation is dealt with by modifying the way in which data is transferred from the buffer store to the frame store in the decoder. The effect of the modification is equivalent to a repetition of 1 field in 5 in one direction, or the suppression of 1 field in 6 in the other. The jerkiness of moving parts of the picture, caused by the repetition or omission of fields, is reduced by the action of the temporal pre-filter.

4.2 Line conversion

The digital pre- and post-filtering in the 525-line terminal is modified so that the number of active lines-per-field used in the coding process remains at 143, the same as in the 625-line terminal. Not only does this minimise differences between the two types of terminal, but also it

provides the line standards conversion between 625 and 525 lines per picture. In addition, it avoids a reduction of vertical definition in 525-line operation and helps to reduce the effects of repeating or omitting fields in the field conversion process.

5. Conclusion

The proposals given above for inter-regional working are still under study and must therefore be regarded as tentative.

The proposals seem attractive because they involve only :

(i) a digital multiplex conversion unit (or transcoder) to interface between 2048 kbit/s and 1544 kbit/s digital paths. A similar or identical unit is required for telephony ;

(ii) A second version of the codec, for use in regions using the 525-line, 60 fields/s television standard. This will differ only slightly from the 625-line version, requiring a small amount of additional circuitry.

In view of the preliminary nature of these proposals, it is proposed that this contribution should be taken as an information document. When the studies have progressed and more comprehensive testing, both of the proposed architecture and of the 525-line codec, has been carried out, a further contribution will propose the appropriate additions to be made to the draft new Recommendation in COM XV-No.134.

APPENDIX

OUTLINE DESCRIPTION OF OPERATION

Since the conditional replenishment codec is a complex and unfamiliar item, this simplified outline of its method of operation is included to make the Recommendation more easily comprehensible. More complete descriptions are to be found in published papers [Duffy & Nicol, 1982] and [Nicol, Chiariglione & Schaefer, 1982].

A conditional replenishment codec operates by transmitting only those parts of a picture which differ significantly from one television frame to the next. This normally gives rise to data being generated in spurts separated by gaps in which no data are being generated. To match the non-uniform data generation to a channel transmitting at a uniform rate, a buffer is used to smooth out short-term fluctuations while, for longer -term variations, the coding algorithm is adaptively modified to change the rate of generation. In the event of too much data, caused for example by a lot of movement, the definition of the transmitted moving area is decreased, taking advantage of the reduced ability of the eye to perceive detail as the rate of movement increases. When little movement is present, the moving-area data are supplemented by data from non-moving areas in such a way that the whole picture is replenished over several picture periods. Picture stores are required at both transmitter and receiver and the objective is to make the content of the receiving store follow that of the transmitting store as closely as possible.

The codec can be regarded as comprising three basic sections: the source codec, the video multiplex codec and the transmission codec. Fig 1 shows an outline of the arrangement.

In the source codec, the video signal is first digitised and pre-filtered. The pre-filter conditions the signal for further processing by reducing noise to improve the performance of the subsequent movement detector and to reduce the subjective effects of subsampling. The movement detector, in conjunction with the picture store, determines which areas in the picture are deemed to be moving. Noise introduces uncertainties in this decision and, when two or more groups of picture elements along a scanning line are deemed to be moving but are separated by small numbers of non-moving picture elements (probably caused by noise), the moving groups and separating elements are combined to form a single cluster, thus minimising the addressing information which is required. Clusters of moving picture elements are then coded using dpcm followed by variable-length (entropy) coding where the shortest codes are allocated to the most frequently-occurring dpcm prediction errors.

The video multiplex codec adds to the video data line- and field-synchronisation signals together with the addressing and other information (for example, whether pcm or dpcm is being transmitted) which must be transmitted in close association with the video to ensure that the decoder responds correctly.

The buffer, which strictly is part of the source coder, accepts the irregularly spaced bursts of data and delivers them at a uniform rate for transmission. The extent to which the buffer is filled is monitored and this is used to modify the rate of data generation by the source coder. It can reduce the data rate by modifying the pre-filter response and the thresholds in the movement detector, and by initiating element and field subsampling.

On the other hand, if the buffer tends to empty, it initiates the generation of complete pcm coded lines to provide systematic updating of the picture stores.

The transmission codec accepts the video data, adds a 64 kbit/s channel for sound, a 32 kbit/s channel for codec-codec signalling and optional additional data channels for facsimile, signalling or other data. It assembles the various signals into a frame structure, defined in draft Recommendation , which is compatible with Recommendation G.732 and therefore suitable for transmission on 2048 kbit/s digital paths. In doing so, it provides the justification facilities to enable the clock for video processing to be independent of the network clock.

References :

Duffy T S & Nicol R C, 1982 : 'A codec for visual teleconferencing'. Communications 82. IEE Conference Publication No 209.

Nicol R C, Chiariglione L & Schaefer P, 1982 : 'The development of the European videoteleconference codec'.

ANNEX 2

PRELIMINARY DRAFT FOR A NEW RECOMMENDATION

A CODEC FOR VIDEOCONFERENCING USING 2048 kbit/s TRANSMISSION

1. Scope

This Recommendation defines the essential features of a codec for the digital transmission, at 2048 kbit/s, of signals for videoconference or visual telephone service in accordance with Recommendation H.61. The video input to the coder and output from the decoder is a 625-line, 50 field/s signal, according to the 'class a' standard of Recommendation H.61, or alternatively, the 313-line, 50 field/s signal of the 'class b' standard. Provision is also made for a sound channel and optional data channels. A brief description of the operation of the codec is given in the Appendix to this Recommendation.

The Recommendation starts with a brief specification of the codec (Section 2) followed by details of the source coder (Section 3) which provides analogue-to-digital conversion followed by recoding with substantial redundancy reduction in the face-to-face mode. The next Section (4) deals with the video multiplex coder which inserts instructions and addresses into the digitised video signal to control the decoder so that it correctly interprets the signals received. Section 5 is the transmission coder which arranges the various digital signals (video, sound, data, signalling) into a form compatible with Recommendation G.732 for transmission over 2048 kbit/s digital paths. Sections 6, 7, 8 and 9 will respectively give details, when these become available, of the graphics coder (providing a graphics facility in accordance with Recommendation H.61), colour facilities, encryption and error correction, and multipoint conference facilities.

2. Brief Specification

2.1 Video input/output - standard 625-line, 50 field/s monochrome (at present) television signals.

2.2 Digital output/input - 2048 kbit/s, compatible with the frame structure of Recommendation G.732.

2.3 Video sampling frequency and 2048 kHz network clock are asynchronous.

2.4 Conditional replenishment coding supplemented by adaptive digital filtering, differential pcm and variable-length coding are used to achieve low bit-rate transmission.

2.5 Audio channel using 64 kbit/s is included. At present, coding is A-law according to Recommendation G.711, but provision is made for future use of more efficient coding.

A recursive temporal pre-filter with non-linear transfer characteristic may be used in the coder. This reduces noise in the signal and increases coding efficiency. This filtering is adaptive under control of the buffer fill.

Details of the filters are under study.

3.4 Conditional Replenishment Coding

A movement detector identifies clusters of picture elements which are deemed to be moving. The basic feature is a frame memory which stores 2 fields of 143 lines, each line containing 256 addressable points. The memory is updated at the picture rate and differences between the incoming signal and the corresponding stored values are used to determine the moving areas in the coder. A similar frame memory must exist at the decoder and be similarly updated under the control of addressing information received from the coder. It is not necessary to specify the techniques used because they do not affect interworking, although they do affect the resultant picture quality.

Detected moving areas are transmitted by differential pcm with a maximum of 16 quantisation levels. The first picture element in each moving area is transmitted by pcm. Variable-length coding is used on the dpcm code words.

Complete pcm lines can be transmitted to provide systematic and forced updating.

3.4.1 DPCM Prediction Algorithm

The algorithm used for dpcm prediction is :

$$X = \frac{A + D}{2}$$, where X is the sample being predicted. (See Fig 1)

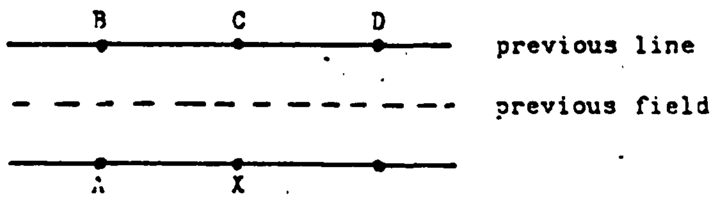


Fig. 1 - Identification of samples

3.4.2 Quantisation Law

Under study.

3.4.3 Variable-Length Code

Under study.

3.5 Subsampling

As the buffer fills, first horizontal subsampling and then field/field subsampling are introduced.

3.5.1 Horizontal Subsampling

Horizontal subsampling is carried out only in moving areas. In this mode, only even elements are transmitted on even numbered lines and odd elements on odd numbered lines. This gives rise to a line quincunx pattern in moving areas.

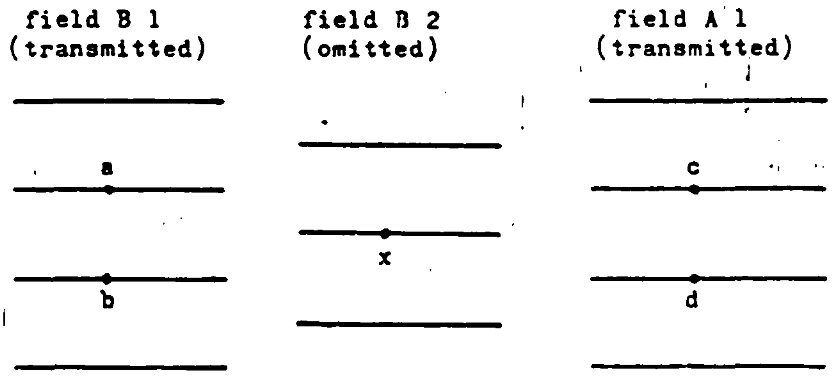
Omitted elements are interpolated in the decoder by averaging the two horizontally adjacent elements.

Adaptive element subsampling allows the transmission of normally omitted elements, either to remove interpolation errors or to provide a softer switch to subsampling and thus improve the picture quality. The signalling of the extra elements is achieved by using, on horizontally subsampled lines only, P quantising levels for normally transmitted elements and the remaining levels for the extra elements. The value of P, the quantising levels for both types of element and the variable-length codes for their transmission are under study.

3.5.2 Field/Field Subsampling

Either field can be omitted. In the omitted field, interpolation takes place only in those parts of the picture which are estimated to be moving. 'Stationary' areas remain unchanged.

The estimated moving areas are formed from an OR function on the moving areas in the past and future fields, as shown :



x is a moving element if a OR b OR c OR d are moving.

The interpolated value of x is the arithmetic average of a, b, c and d.

$$x = \frac{a + b + c + d}{4}$$

Note:- a, b, c and d need not have been moving in their respective fields.

4. Video Multiplex Coding

4.1 Buffer Store

The size of the buffer store is defined at the transmitting end only. Its delay is approximately equal to the duration of one picture (40 ms).

At the receiving end, the buffer must be of at least this length, but in some implementations of the decoder it may be longer.

4.2 Video Synchronisation

The method used for video synchronisation permits the retention of the picture structure. The required information is transmitted in the form of Line Start and Field Start codes (LST and FST).

4.2.1 Line Start Code

The line start code includes a synchronisation word, a line number code and a digit to signal the presence of element subsampling.

4.2.2 Field Start Code

There are two field start codes FST-1 and FST-2, where the first line of the field following FST-2 is interlaced between the first two lines of the field following FST-1.

Field subsampling is signalled by two consecutive field start codes of the same number. For example:

| FST-1 | field of data | FST-1 | field of data |

signifies that field 2 has been omitted and that its moving areas must be interpolated as described in Section 3.5.2.

4.3 Addressing of Moving Areas

The positions of the clusters of picture elements along each line which are deemed to form parts of moving areas are addressed by means of an address of the start of the cluster and an 'End of Cluster' code (EOC).

The minimum gap between the end of one cluster and the start of the next, and the minimum length of a cluster need to be specified.

4.4 PCM Lines

PCM lines are used for systematic or forced updating and are signalled by using a LST followed by an invalid cluster address (or last element of a line) and an invalid pcm value (outside permitted video range).

./.

5. Transmission Coding

The transmission coder assembles the video, audio, signalling and optional data channels into a 2048 kbit/s frame structure which is compatible with Recommendation G.732. It also provides justification facilities to enable the video sampling frequency to be independent of the network clock.

5.1 Serial Data

With all serialised data (video, audio and addressing), the most significant digit leads. Positive logic is used throughout.

5.2 Audio

The audio is coded into 64 kbit/s using A-law pcm, as specified in Recommendation G.711.

In the coder, the delay difference between the coded audio and video when the buffer is empty should be within $\pm$ 5 ms. In the decoder the delays must also be equalised. the tolerance is under study.

The audio output should be muted in the event of loss of frame alignment.

5.3 Transmission Framing

The frame structure is defined in a proposal for a new Recommendation (document COM-XV-No. 123).

6. Graphics Coder

Under study.

7. Colour Facilities

When colour is being transmitted, the input (and output) video signals are in component form. The luminance and colour-difference components, E'_Y, E'_U and E'_V, are as defined in CCIR Report 624-2. The luminance component, E'_Y, is processed in exactly the same manner as the monochrome signal, as described in Section 3.

The colour-difference signals are each sampled to produce 52 samples per active line and are converted to 8-bit pcm. The sampling patterns, the arrangement of the samples and the quantisation levels are under study.

The E'_U and E'_V samples are stored and transmitted on alternate lines of the coded picture. The first active line of field No.1 is E'_U and the first active line of field No.2 is E'_V. The colour-difference signal not being transmitted during any line is obtained at the decoder by interpolation.

The colour-difference signals are coded using conditional-replenishment techniques similar to those used for the luminance (or monochrome) signal.

The colour-difference signals are multiplexed with the luminance signal (and addressing and synchronisation data) in the Video Multiplex Coder.

8. Error Correction and Encryption

8.1 Error Correction

Provision is made for the optional use of forward error correction. This is required if the channel error rate is worse than 1 in 10^6 for significant periods of time. The error corrector used is a (4095, 4035) five-error correcting BCH* code. The error correcting decoder has the ability to correct up to five isolated errors and one burst of up to 26 errors in each block. At a channel error probability of 1×10^{-4}, the corrected error rate is 1.25×10^{-8}. The 60 parity bits which are required are obtained by removing the video from Time Slots 24 - 31 of frame number 15 of each multiframe.

---

*BCH = Bose, Chaudhuri and Hocquenghem

8.2 Encryption

Under study.

9. Multipoint Conference Facilities

Under study

Footnote. It should be studied whether it is necessary to specify whether the error correction should be made either on the satellite link or directly on the signal or on both

Appendix:

APPENDIX E

"III. Explanation of New Material"

Part of

Communications Network Service

Section 61.38 Information

as submitted to the

Federal Communications Commission

by

Satellite Business Systems

III. EXPLANATION OF NEW MATERIAL

Communications Network Service (CNS) is SBS's initial operational system service offering. In regard thereto, the following are provided: System Description Overview; Service Description Overview; Planned Service Features; and Summary of Key Tariff Provisions.

A. SYSTEM DESCRIPTION OVERVIEW */

The major components of the SBS System are the ground segment, the space segment and the support segment.

The ground segment consists of earth stations and of the following earth station components:

- Port Adaptor System (PAS), which is the interface between the SBS System and the terrestrial portion of a customer's communications network;
- Satellite Communications Controller (SCC), which provides for analog/digital conversion for voice-grade signals, Time Division Multiple Access (TDMA), demand assignment, switching, control and processing;
- TDMA Burst Modem, which modulates and demodulates the information to be transmitted over the satellite link;
- Radio Frequency Terminal (RFT), which sends transmissions to and receives transmissions from the satellite;
- Monitor and Command system, which is the control interface between the customer-premises earth station and the SBS support segment.

The space segment consists of satellites and satellite monitoring and control facilities. The monitoring and control facilities consist of two Telemetry, Tracking and Command earth stations, and the Satellite Control Facility, which receives and analyzes data received from the satellites concerning their status.

*/ A more detailed description of the SBS System is contained in Appendix A.

The support segment involves all SBS functions not included in the network signal path, including the performance of space and ground components. The ground components consist of a centrally-located Network Control Center (NCC), which monitors the performance of all networks, collects traffic and billing data, and provides data to the SBS maintenance organization and to Operations and Maintenance Centers that perform maintenance and repairs. The space component includes the Radio Frequency Spectrum Monitor (RFSM) that monitors the RF performance of each satellite access link.

Figure 1 , Page III-3, depicts the basic components of the SBS System.

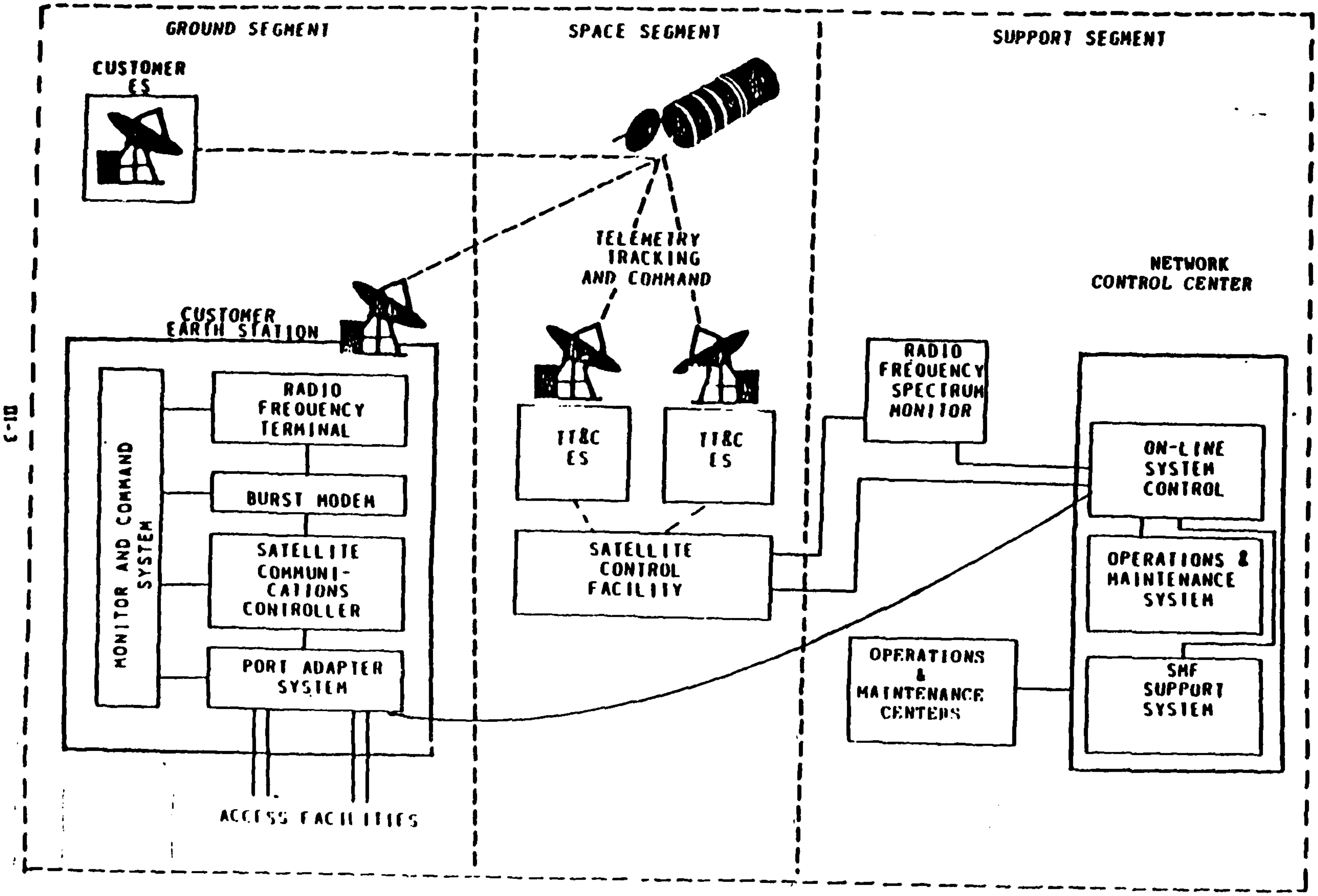


FIGURE 1. BASIC COMPONENTS OF THE SBS SYSTEM

B. SERVICE DESCRIPTION OVERVIEW

CNS is a private switched network service designed to meet the needs of commercial, governmental and other institutional users whose telecommunications requirements encompass a variety of applications at geographically-dispersed customer locations within the contiguous United States.

CNS is being proposed to meet the intercity telecommunications requirements of large and medium-sized telecommunications users. In order to better serve the varying needs of different customers with private network requirements, SBS, as previously noted, is planning to offer two series of CNS--CNS-A and CNS-B. Generally, CNS-A customers will have larger call volumes and higher traffic concentration at their locations than CNS-B customers.

CNS-A

CNS-A is the initial SBS offering to be made available. It permits two-point and multipoint operation via satellite and other transmission facilities. CNS-A will enable the customer to transmit voice, image and data among earth stations (Network Access Centers or NACs) that are located on a customer's premises or terrestrial extensions therefrom.

Figure 2, page III-6, shows the major CNS service components. Each customer network must include a minimum of three NACs and three Full-Time Transmission Units (FTUs). Connection Arrangement Units (CAUs) connect access lines to a NAC. Access lines may be provided by the customer or they may be furnished by SBS, in which case they will be provided pursuant to tariff. Generally, such access lines are called Service Extensions if they are obtained by SBS from other carriers. Other access facilities acquired or constructed by SBS may be provided as Special Construction, an offering under the Special Services Section of the tariff.

CNS-A Service Components

- Network Access Centers

  A NAC consists of Company-provided and maintained earth station facilities that are located on premises designated by the customer. NACs provide access to CNS and accommodate the switching, administration and testing of the service.

- Transmission Units

  A Transmission Unit (TU) is 224 kbps (simplex) of assigned satellite transponder capacity and consists of the transmission path between or among NACs. A Full-Time Transmission Unit (FTU) is one TU assigned to a customer's network 24 hours per day, seven days per week. A Demand Transmission Unit (DTU) is one TU assigned to a customer's network on an as-needed basis for digital applications. DTUs will be provided to several customers, on an as-available basis, from a common pool of satellite transponder capacity.

- Connection Arrangement Units

  Connection Arrangements Units (CAUs) are the means by which Service Extensions, specially-constructed access facilities, and customer-provided access facilities are connected to CNS. Two basic types of CAUs are offered: analog for voice applications, and digital for data, facsimile and teleconferencing applications. Table 1, page III-8, shows the available CAUs.

- Service Extensions

  At the customer's request, SBS will acquire from other carriers access lines to interconnect CAUs at NACs with remote customer premises. These Service Extensions will be provided when SBS can obtain the required access facilities from another common carrier by other than special construction.

- Special Services

  SBS may undertake to provide Special Services, including Special Construction, which are incidential to the provision of CNS.

CNS-A

MAJOR SERVICE COMPONENTS

COMMUNICATIONS NETWORK SERVICE

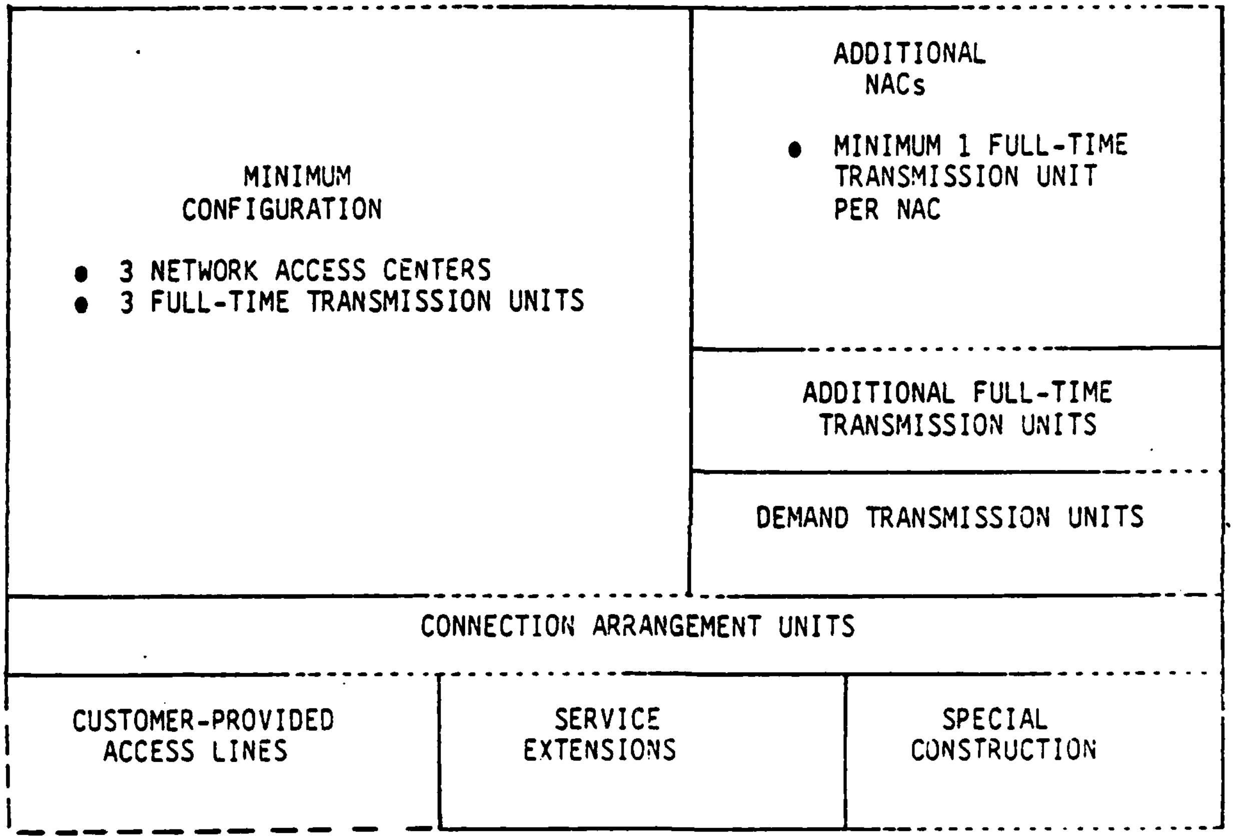


FIGURE 2

CNS-A Standard Service Features

The standard service features for CNS-A are listed below.

- Switched and Nonswitched Connections
- Two-Point and Multipoint Calling
- Uniform Numbering Plan
- Customer Network Management
- Customer Network Management Reports
- Dynamic Capacity Allocation
- Forward Error Correction
- Digital Call Queuing
- Voice Activity Compression
- Intranodal Call Blocking
- Automatic Connection
- Recorded Voice Announcements
- Echo Control
- Off-Net Calling via Customer-Provided Facilities or Services
- Route Selection for Off-Net Calls

In addition, Enhanced Echo Control is offered as an optional service feature.

TABLE I
SUMMARY OF CONNECTION ARRANGEMENT UNITS
(CNS-A)

DESIGNATION	DESCRIPTION	DESIGNATION	DESCRIPTION
A1	-- Nonswitched Voice -- Nonswitched Analog Data (up to 2400 bps)		
A2	-- Switched Voice -- Switched Analog Data (up to 2400 bps)		
A3	-- Automatic Connection (limit: 32 per NAC)		
D1-2.4	-- Nonswitched Synchronous Digital Data at 2.4 kbps	D2-2.4	-- Switched Synchronous Digital Data at 4.8 kbps
D1-4.8	-- Nonswitched Synchronous Digital Data at 4.8 kbps	D2-4.8	-- Switched Synchronous Digital Data at 4.8 kbps
D1-9.6	-- Nonswitched Synchronous Digital Data at 9.6 kbps	D2-9.6	-- Switched Synchronous Digital Data at 9.6 kbps
D1-19.2	-- Nonswitched Synchronous Digital Data at 19.2 kbps	D2-19.2	-- Switched Synchronous Digital Data at 19.2 kbps
D1-56	-- Nonswitched Synchronous Digital Data at 56 kbps	D2-56	-- Switched Synchronous Digital Data at 56 kbps
D1-112	-- Nonswitched Synchronous Digital Data at 112 kbps	D2-112	-- Switched Snychronous Digital Data at 112 kbps
D1-224	-- Nonswitched Synchronous Digital Data at 224 kbps	D2-224	-- Switched Synchronous Digital Data at 224 kbps
D1-448	-- Nonswitched Synchronous Digital Data at 448 kbps	D2-448	-- Switched Synchronous Digital Data at 448 kbps
D1-1344	-- Nonswitched Synchronous Digital Data at 1344 kbps	D2-1344	-- Switched Synchronous Digital Data at 1344 kbps
D1-1544	-- Nonswitched Synchronous Digital Data at 1544 kbps	D2-1544	-- Switched Synchronous Digital Data at 1544 kbps
D1-3088	-- Nonswitched Nonsynchronous Digital Data at 3088 kbps	D2-3088	-- Switched Nonsynchronous Digital Data at 3088 kbps

CNS-B

CNS-B permits the establishment of private customer networks via SBS-provided earth stations and other facilities that are shared by customers. It will be introduced in January 1982, one year after CNS-A. Service enhancements, including new features, will be added to CNS-B as they become available by virtue of SBS operational system changes. The offering will achieve maturity in 1983.

CNS-B is provided via Network Access Centers that are located at CNS-B customer premises and via Service Points that are located in the cities listed in Table 3, page III-16. Thus, CNS-B customers can develop private networks without a need to establish NACs at or near all the points of communication they desire to access.

While CNS-B will make available many of the features and capabilities of CNS-A, there are significant differences between CNS-A and CNS-B, as shown in Table 2, page III-11.

A NAC provided to a CNS-B customer will have held in reserve by SBS approximately one-third of its capacity in order that SBS may provide Service Points and the Optional Off-Net Calling feature to CNS-B customers. Thus, while a CNS-A customer can avail itself of all the capacity and capabilities at its dedicated NAC, CNS-B customer capacity and capabilities will be limited to accommodate the shared use of the NAC by more than one customer. As indicated in Table 2, a CNS-B customer is limited to the equivalent of seventy-five (75) Transmission Units per network. This is because CNS-B is provided via the same satellite transponder serving all CNS-B customers. In contrast, CNS-A is not provided via the same transponder for all customers. Finally, while CNS-A customers are afforded service features for the individual management of their networks, some of the same features are not provided to CNS-B customers. For example, for CNS-B, SBS will specify the message content of the Recorded Voice Announcements and SBS will average the Voice Activity Compression (VAC) effect for all voice calls in CNS-B customer networks in order to meet overall SBS CNS-B requirements and to insure appropriate service quality.

As previously indicated, a significant feature to be associated with CNS-B is the Optional Off-Net Calling feature which will permit customers to place calls from locations on the customer's network to telephone stations located within the local exchange areas of telephone companies. This will be achieved by SBS obtaining appropriate facilities from telephone companies, which facilities will connect CNS-B NACs to the local exchange networks of telephone companies, thereby allowing CNS-B customers to use such facilities on a shared basis to reach off-net stations.

Analog voice-grade connections between the customer's location and a Service Point located within the same "exchange area," as defined in the tariffs of the serving telephone company, are called Service Point Extensions. All other SBS-provided access lines connecting a NAC or Service Point to a customer- location are called Service Extensions. Other access facilities provided by or for SBS may be provided as Special Construction pursuant to tariff terms and conditions.

The service components of CNS-B are Network Access Centers, Service Points, Transmission Units, Connection Arrangement Units, Service Extensions, Service Point Extensions, Special Construction, and Other Special Services. (See Figure 3, Page III-12.)

As suggested above, in order for SBS to provide CNS-B, certain additions must be made to its operational system. Due to the nature of these changes, SBS will not offer initially a full CNS-B capability, but will introduce a more basic and limited version. For example, there may be limitations on the maximum number of Service Points in a customer network and availability of data capabilities at Service Points. The initial CNS-B offering will evolve into a mature CNS-B offering when necessary changes to the operational system are completed in 1983.

Because CNS is a single offering and, further, because CNS-B will be furnished within the period for which financial data is presented herein, such data reflect costs associated with CNS-A and CNS-B.

CNS-B is described in more detail in the following pages and in the Informational Tariff contained in Appendix D.

TABLE 2

COMPARISON OF CNS-A VS CNS-B

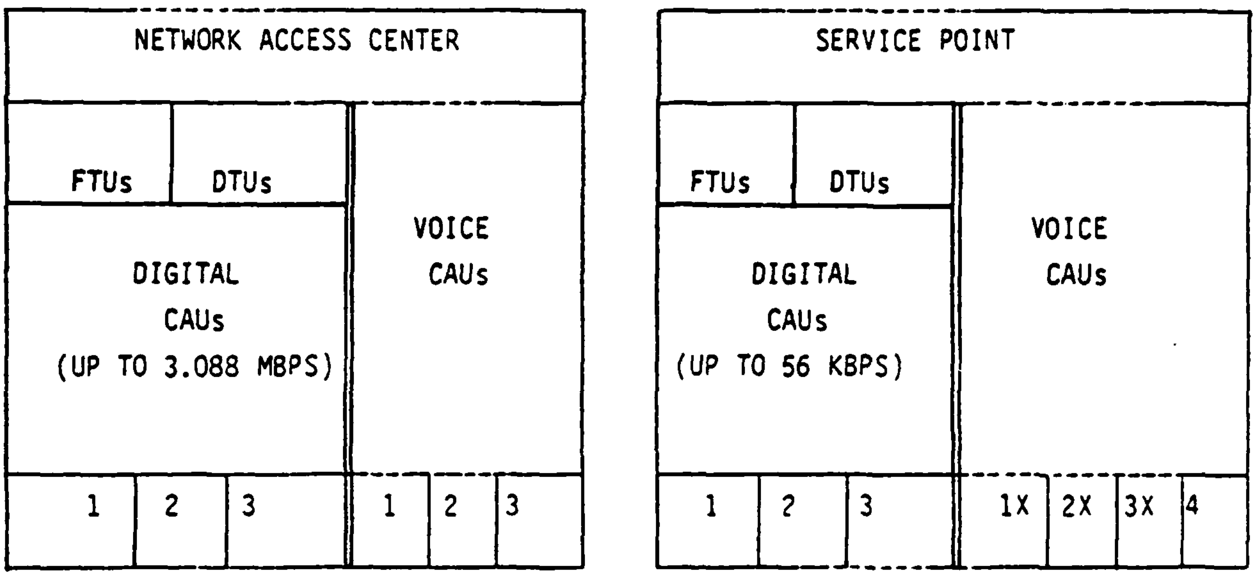
FEATURE	CNS-A	CNS-B
Data Speeds	Up to 3.088 Mbps	Up to 3.088 Mbps at NACs, Limited to 56 Kbps at Service Points
Network Transmission Limitations	None*/	Maximum of 75 TUs per Unit Customer Network
Voice Activity Compression	Customer Receives Full VAC Effect	Not Offered, but VAC Effect is Reflected in Voice CAU Rate
Dynamic Capacity Allocation	Applicable to Voice and Data Calls	Applicable Only to Data Calls
Blocking Codes	Up to 32 Codes per NAC	Up to 17 Codes per NAC and 5 Codes per Service Point
Automatic Connections	Yes	Not Available at Service Points
Recorded Voice Announcements	Customer-Specified Announcements	SBS-Specified Announcements

*/ The CNS-A customer network is limited only to the extent of available satellite transponder capacity.

CNS-B

MAJOR SERVICE COMPONENTS

COMMUNICATIONS NETWORK SERVICE



1 SERVICE EXTENSIONS

1X SERVICE EXTENSIONS (INTEREXCHANGE ONLY)

2 SPECIAL CONSTRUCTION

2X SPECIAL CONSTRUCTION (INTEREXCHANGE ONLY)

3 CUSTOMER-PROVIDED ACCESS LINES

3X CUSTOMER-PROVIDED ACCESS LINES (INTEREXCHANGE ONLY)

4 SERVICE POINT EXTENSIONS

FIGURE 3

CNS-B Service Components

- Network Access Centers

A NAC will consist of Company-provided and maintained earth station facilities that are located on premises designated by the customer. NACs provide access to CNS and accommodate the switching, administration and testing of the service. A customer's voice, image, and data terminals on or near the NAC location generally will be connected to the NAC by "in-house" cabling. Locations remote from the NAC will be interconnected generally via conventional terrestrial access facilities.

- Service Points

Service Points consist of SBS-provided facilities that accommodate switching and access to CNS-B via analog voice-grade CAUs and via digital CAUs at data rates less than or equal to 56 kbps. Service Points are planned to be located in the cities listed in Table 3, Page III-16.

- Transmission Units

A Transmission Unit (TU) is 224 kbps (simplex) of assigned satellite transponder capacity available for digital applications. (Transmission capacity for voice calling is included with analog voice-grade CAUs.) A Full-Time Transmission Unit (FTU) is one TU assigned 24 hours per day, 7 days per week, to a customer's network. A Demand Transmission Unit (DTU) is one TU assigned to a customer's network on an as-available basis from a common pool of satellite transponder capacity.

- Connection Arrangement Units

Connection Arrangement Units (CAUs) are the means by which Service Extensions, Service Point Extensions, Special Construction and customer-provided facilities are connected to CNS. Two basic types of CAUs are offered: CAUs for the transmission of voice and analog data, and CAUs for the transmission of digital data. Table 3, Page III-16, is a summary of the features and capabilities of available CAUs. Analog voice-grade CAUs are provided with the satellite transponder capacity needed to complete calls and thus the planning rate for voice CAUs reflect the inclusion of such capacity; digital calls require TU capacity in addition to CAUs.

- Service Extensions

At the customer's request, SBS will acquire from other common carriers access lines to interconnect CAUs at NACs with co-located or remote customer premises. Service Extensions will be provided when SBS can obtain the required access facilities from another common carrier without special construction.

- Service Point Extensions

SBS will provide Service Point Extensions to connect analog voice-grade CAUs at Service Points to an initial point of connection at a Customer Premises that is in the same exchange area as the Service Point.

- Special Services

SBS may undertake to provide Special Services, including Special Construction of facilities, in order to connect a NAC to a remote customer premises.

TABLE 2

CNS-B

SERVICE POINT LOCATIONS

Atlanta, GA
Boston, MA
Chicago, IL
Cincinnati, OH
Dallas, TX
Denver, CO
Detroit, MI
Houston, TX
Los Angeles, CA
Miami, FL
Minneapolis, MN
New Orleans, LA
New York, NY
Philadelphia, PA
Phoenix, AZ
Pittsburgh, PA
St. Louis, MO
San Francisco, CA
Seattle, WA
Washington, D.C.

TABLE 3

SUMMARY OF CONNECTION ARRANGEMENT UNITS (CNS-B)

DESIGNATION	DESCRIPTION	DESIGNATION	DESCRIPTION
A1	-- Nonswitched Voice -- Nonswitched Analog Data (up to 2400 bps)		
A2	-- Switched Voice -- Switched Analog Data (up to 2400 bps)		
A3	-- Automatic Connection (limit: 32 per NAC)		
D1-2.4	-- Nonswitched Synchronous Digital Data at 2.4 kbps	D2-2.4	-- Switched Synchronous Digital Data at 4.8 kbps
D1-4.8	-- Nonswitched Synchronous Digital Data at 4.8 kbps	D2-4.8	-- Switched Synchronous Digital Data at 4.8 kbps
D1-9.6	-- Nonswitched Synchronous Digital Data at 9.6 kbps	D2-9.6	-- Switched Synchronous Digital Data at 9.6 kbps
D1-19.2	-- Nonswitched Synchronous Digital Data at 19.2 kbps	D2-19.2	-- Switched Synchronous Digital Data at 19.2 kbps
D1-56	-- Nonswitched Synchronous Digital Data at 56 kbps	D2-56	-- Switched Synchronous Digital Data at 56 kbps
D1-112*	-- Nonswitched Synchronous Digital Data at 112 kbps	D2-112*	-- Switched Snychronous Digital Data at 112 kbps
D1-224*	-- Nonswitched Synchronous Digital Data at 224 kbps	D2-224*	-- Switched Synchronous Digital Data at 224 kbps
D1-448*	-- Nonswitched Synchronous Digital Data at 448 kbps	D2-448*	-- Switched Synchronous Digital Data at 448 kbps
D1-1344*	-- Nonswitched Synchronous Digital Data at 1344 kbps	D2-1344*	-- Switched Synchronous Digital Data at 1344 kbps
D1-1544*	-- Nonswitched Synchronous Digital Data at 1544 kbps	D2-1544*	-- Switched Synchronous Digital Data at 1544 kbps
D2-3088*	-- Nonswitched Nonsynchronous Digital Data at 3088 kbps	D2-3088*	-- Switched Nonsynchronous Digital Data at 3088 kbps

* Offered at NACS only.

CNS-B Standard Service Features

The standard service features for CNS-B are listed below.

- Switched and Nonswitched Connection
- Two-Point and Multipoint Calling
- Uniform Numbering Plan
- Customer Network Management
- Customer Network Management Reports
- Dynamic Capacity Allocation
- Forward Error Correction
- Digital Call Queuing
- Intranodal Call Blocking
- Automatic Connection
- Recorded Voice Announcements
- Echo Control
- Off-Net Calling via Customer-Provided Facilities or Services
- Route Selection for Off-Net Calls

CNS-B Optional Service Features

In addition, the following features are offered for an additional charge.

- Optional Off-Net Calling

Optional Off-Net Calling provides for analog voice-grade calls terminating at an off-net station in a Metropolitan Calling Area listed in Table 4, Page III-18.

- Enhanced Echo Control

Echo cancelers are available to enhance the echo suppression built into analog voice-grade CAUs. Echo cancelers are recommended when calls are completed via the public switched network, when there are long distances between the stations and the NAC, or whenever improved voice quality is required.

TABLE 4

PLANNED METROPOLITAN CALLING AREAS FOR OPTIONAL OFF-NET CALLING

Abilene, TX
Akron, OH
Albany/Schenectady
Troy, NY
Albuquerque, NM
Allentown, PA
Ann Arbor, MI
Asbury Park, NJ
Asheville, NC
Atlanta, GA
Augusta, GA
Austin, TX
Bakersfield, CA
Baltimore, MD
Baton Rouge, LA
Beaumont, TX
Binghmaton, NY
Birmingham, AL
Boston, MA
Bridgeport, CT
Buffalo, NY
Camden, NJ
Canton, OH
Cedar Rapids, IA
Champaign/Urbana, IL
Charleston, SC
Charleston, WV
Charlotte, NC
Chattanooga, TN
Chicago, IL
Cincinnati, OH/KY
Cleveland, OH
Columbia, SC
Columbus, GA
Columbus, OH
Corpus Christi, TX
Dallas, TX
Davenport/Rock Island/
Moline, IA/IL
Dayton, OH
Decatur, IL
Denver, CO
Des Moines, IA
Detroit, MI
Duluth, MN
El Paso, TX/NM
Erie, PA
Evansville, IN
Flint, MI
Ft. Lauderdale, FL
Fort Wayne, IN
Fort Worth, TX
Fresno, CA
Gary/Hammond, IN
Grand Rapids, MI
Greensboro, NC
Greenville, SC
Harrisburg, PA
Hartford, CT
Houston, TX
Huntington, WV
Indianapolis, IN
Jackson, MS
Jacksonville, FL
Kalamazoo, MI
Kansas City, MO/KS
Knoxville, TN
Lancaster, PA
Lansing, MI
Las Vegas, NV
Lexington, KY
Little Rock, AR
Los Angeles, CA
Louisville, KY
Macon, GA
Madison, WI
Memphis, TN
Miami, FL
Milwaukee, WI
Minneapolis/
St. Paul, MN
Mobile, AL
Montgomery, AL
Nashville, TN
New Bedford, MA
New Brunswick, NY
New Haven, CT
New Orleans, LA
New York, NY
Newark/Patterson, NJ
Newport News, VA
Norfolk, VA
Oklahoma City, OK
Omaha, NB/IA
Orlando, FL
Pensacola, FL
Peoria, IL
Philadelphia, PA
Phoenix, AZ
Pittsburgh, PA
Portland, ME
Portland, OR
Providence, RI
Racine, WI
Raleigh, NC
Reading, PA
Richmond, VA
Riverside, CA
Rochester, NY
Rockford, IL
Sacramento, CA
Saginaw, MI
St. Louis, MO/IL
St. Petersburg, FL
Salt Lake City, UT
San Antonio, TX
San Diego, CA
San Francisco/
Oakland, CA
San Jose, CA
Santa Ana, CA
Savannah, GA
Scranton/Wilkes-
Barre, PA
Seattle, WA
Shreveport, LA
Sioux Falls, SD
South Bend, IN
Spokane, WA
Springfield, IL
Springfield, MA
Stamford, CT
Stockton, CA
Syracuse, NY
Tacoma, WA
Tampa, FL
Toledo, OH/MI
Topeka, KS
Trenton, NJ
Tucson, AZ
Tulsa, OK
Utica, NY
Vallejo, CA
Ventura, CA
Waco, TX
Washington, DC/VA/MD
West Palm Beach, FL
Wheeling, WV
White Plains, NY
Wichita, KS
Wilmington, DE
Winston-Salem, NC
Worcester, MA
York, PA
Youngstown, OH

C. PLANNED CNS FEATURES

The following are CNS features which SBS is planning to offer subsequent to the introduction of service in 1981. A description of these features is included because SBS has committed to implementing them and costs already have been incurred in their development. Such costs are reflected in Section VI.

- Capacity Transfer Control

The Capacity Transfer Control (CTC) feature permits allocated capacity to be shared among participants in a switched broadcast connection. Such capacity will be capable of being transferred among NACs involved in a broadcast connection.

- Synchronous 3.152 Mbps Connection Arrangement Unit

This type of CAU will be used for business-conference quality full-motion video teleconferencing and other high-speed data applications.

- Synchronous 6.312 Mbps Connection Arrangement Unit

This type of CAU will be used for high-quality full-motion video teleconferencing and for very high-speed data applications.

- Bulk Encryption

Bulk Encryption will use the federally approved Data Encryption Standard (DES) algorithm to provide a security encrypting code to be applied to all of a customer's traffic between or among NACs.

- Enhanced Off-Net Call Routing

  - Eight-way Routing

    Five (5) additional alternate routes will be available at a NAC in order to increase customer flexibilities for off-net call completion.

  - Six Digit Call Routing

    Presently off-net calls are routed to a customer-designated NAC based on the first three digits (area code) of the normal ten-digit call dialing sequence (NPA-NNX-XXXX). The provision of six-digit call routing will permit an off-net call to be completed through the customer NAC that most economically serves the destination station.

- Inband Signaling

  Inband Signaling will permit the customer's terminal equipment call signaling to use the same path as the data which is transmitted or received. This type of interface will provide a means for facilitating the establishment of switched digital calls. The main features are its provision of signaling independent of data transmission rate and its provision of sophisticated call progress information.

- Enhanced Customer Network Management (CNM)

  SBS plans to enhance the CNM capability to provide more customer control of networks. Enhanced CNM is also anticipated to provide the customer with additional reports as well as status and graphic display capabilities.

D. SUMMARY OF TARIFF RATES AND NOTICE PERIODS

Summary of Rates

This summary contains the nonrecurring and recurring charges for CNS, including Network Access Centers, Transmission Units, Connection Arrangement Units, Service Extensions, and the Enhanced Echo Control option. In addition, Maintenance Service Charges and Move Charges are shown.

CNS-A

Network Access Centers (each)

Shipping Charges to NAC site	$7,000
Installation of Intra-NAC Facility Link (For all cables installed at the same NAC at the same time.)	$1,000 plus $13 per foot
Monthly Recurring Charge per NAC	$12,500
Maximum Termination Charge per NAC	$150,000

The actual Termination Charge will be the Maximum Termination Charge reduced by 1/12 for each month that the NAC is in service.

Transmission Units

- Full-Time Transmission Units (each 224 kbps of capacity)

Installation Charge	None
Monthly Recurring Charge	$2,100

- Demand Transmission Units (each 224 kbps of capacity)

Installation Charge	None
Charge per second or fraction thereof	1.12¢

Connection Arrangement Units (Per Unit)

Installation Charge	$100
Monthly Recurring Charge	See Tables Below

Analog Voice-Grade Connection Arrangement Units

Number of CAUs	Monthly Recurring Charge
1 CAU to 150 CAUs	$110 per CAU
151 CAUs to 200 CAUs	$16,500 plus $95 per CAU in excess of 150
201 CAUs to 250 CAUs	$21,250 plus $80per CAU in excess of 200
251 CAUs to 300 CAUs	$25,250 plus $65 per CAU in excess of 250
More than 300 CAUs	$28,500 plus $50 per CAU in excess of 300

Digital Connection Arrangement Units

CAU Type	Monthly Recurring Charge Per Unit	CAU Type	Monthly Recurring Charge Per Unit
D1-2.4	$150	D2-2.4	$165
D1-4.8	$250	D2-4.8	$275
D2-9.6	$350	D2-9.6	$385
D1-19.2	$500	D2-19.2	$550
D1-56	$700	D2-56	$770
D1-112	$1,100	D2-112	$1,210
D1-224	$1,500	D2-224	$1,650
D1-448	$1,800	D2-448	$1,980
D1-1344	$2,500	D2-1344	$2,750
D1-1544	$2,500	D2-1544	$2,750
D1-3088	$3,000	D2-3088	$3,300

Service Extensions

The rates specified in the tariff of the Other Common Carrier from which the facility or service is obtained, plus a recurring and a nonrecurring administrative charges per extension, as follows:

Nonrecurring Charge	$25
Monthly Recurring Charge	$12

Service Extension Support

A service extension support charge applies if, in order to provide Service Extensions, it is necessary to have an Other Common Carrier specially construct entrance or building cables. In addition, the Customer is responsible for any associated nonrecurring charges, monthly recurring charges, termination liabilities and underutilization liabilities in accordance with the tariff of the Other Common Carrier.

Nonrecurring Charge Per Order	$560

Maintenance Service Charge

A maintenance service charge of $65 per man-hour or major fraction thereof, with a minimum charge of one man-hour, applies when a service difficulty or trouble report results from Customer-provided or Authorized User- provided facilities connected to CNS.

Optional Service Feature

- Enhanced Echo Control (Per CAU)

Installation Charge	None
Monthly Recurring Charge	$15

Move Charges

When the physical location of a Company-provided service component is changed at a customer premises at the customer's request, Special Service charges apply.

Summary of Minimum Service Period and Termination Notice Periods

CNS-A

Component	Minimum Service Periods	Minimum Termination Notice Periods
Network Access Centers (including associated minimum FTU's-	None *	90 Days
Transmission Units Full-Time	30 Days	7 Days
Connection Arrangement Units	30 Days	30 Days
Optional Service Features	30 Days	30 Days
Service Extensions	Minimum period imposed upon the Company under the applicable tariff.	Minimum period imposed upon the Company under the applicable tariff of the Other Common Carrier plus 5 days.

For any customer who ordered service before January 1, 1981, the above requirements will be waived for a one-year period immediately following the initial notice of availability of service. This waiver does not apply to Service Extensions or Special Services.

*/ There is, however, a Termination Charge. See Page III-21.

END

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